Atoms for Peace

Atoms for Peace in the 21st Century

A New Generation of Nuclear Energy

A half century of work harnessing "Atoms for Peace" has achieved tremendous advances in technology and quality of life. However, further advances are needed to meet the world's urgent need for clean, safe, economical energy. Research and development is underway on an advanced generation of nuclear energy systems – known as Generation IV – that will help:

- Meet surging energy demand around the world without increasing emissions of greenhouse gases.
- Provide a better quality of life for billions of people around the world now living in poverty.
- Create a bridge to the hydrogen economy by allowing large-scale, emissions-free, economical production of hydrogen.

A Global Effort to Create Tomorrow's Energy Systems

To meet future energy needs, 10 countries – Argentina, Brazil, Canada, France, Japan, the Republic of Korea, South Africa, Switzerland, the United Kingdom and the United States – have created a framework for international cooperation in research to develop future-generation nuclear energy systems. These countries, together with the European Atomic Energy Community (EURATOM), have formed the Generation IV International Forum (GIF) to develop a new generation of advanced systems.

At the direction of the U.S. Secretary of Energy, Generation IV research in the United States is being led by the Idaho National Engineering and Environmental Laboratory, in full collaboration with other laboratories, industry and major research universities.

The Generation IV Technology Roadmap

The goal of the Generation IV effort is to have an advanced new nuclear energy system – encompassing everything from fuel to power generation

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The Idaho National Engineering and Environmental Laboratory is a science-based, applied engineering national laboratory dedicated to supporting the U.S. Department of Energy's missions in energy security, national security, environment and science.

Idaho National Engineering and Environmental Laboratory

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to waste management – ready for deployment by 2030.

The GIF has identified six nuclear systems as the most promising technologies for meeting vital safety, economic, waste and nonproliferation goals: gas-cooled fast reactor system (GFR); molten salt reactor system (MSR); sodium liquid metal-cooled reactor system (SFR); lead alloy-cooled fast reactor system (LFR): supercritical water-cooled reactor system (SCWR); and very high temperature reactor system (VHTR). These systems are expected to be ready for demonstration by 2020.

A Key to the Hydrogen Economy

Hydrogen holds great promise as an abundant, emissions-free alternative to oil as a transportation fuel, but large amounts of electricity will be needed to produce adequate hydrogen supplies. High temperature Generation IV reactors will be able to produce the zero-emissions electricity needed to produce hydrogen by conventional means, and will be able to produce hydrogen directly from water using high-temperature electrolysis and thermochemical water splitting.

Generations of Nuclear Energy

- **Generation I: 1950s – 1960s**
  Early prototype reactors
- **Generation II: 1970s – 1990s**
  Almost all of the commercial power reactors in operation today are Generation II designs
- **Generation III: Today**
  Standardized designs with advanced efficiency and safety features
- **Generation IV: 2030 and beyond**
  Innovative advanced energy systems that are highly economical, safe, produce minimal waste and are proliferation resistant

Minimizing Waste Through an Advanced Fuel Cycle

An important component of the research effort on the next generation of nuclear power generation is to improve the long-term sustainability of nuclear energy by dramatically reducing the amount of waste generated by nuclear power reactors. The goals of the Advanced Fuel Cycle Initiative are to:

- Reduce the cost of disposing of commercial spent nuclear fuel.
- Reduce inventories of civilian plutonium in the U.S.
- Reduce the toxicity of high-level nuclear waste that goes into long-term geological storage.
- Enable more effective use of the currently proposed geological waste repository so it will be able to serve the needs of the U.S. for the foreseeable future.

Goals for Generation IV Nuclear Energy Systems

Safety & Reliability. Generation IV nuclear energy systems operations will:
- excel in safety and reliability.
- have a very low likelihood and degree of reactor core damage.
- eliminate the need for offsite emergency response.

Economics. Generation IV nuclear energy systems will:
- have a clear life-cycle cost advantage over other energy sources.
- have a level of financial risk comparable to other energy projects.

Sustainability. Generation IV nuclear energy systems will:
- provide sustainable energy generation that meets clean air objectives and promotes long-term availability of systems and effective fuel utilization for worldwide energy production.
- minimize and manage their nuclear waste and notably reduce the long-term stewardship burden in the future, thereby improving protection for the public health and the environment.

Proliferation Resistance & Physical Protection. Generation IV nuclear energy systems will:
- increase the assurance that they are a very unattractive and least desirable route for diversion or theft of weapons-usable materials, and provide increased physical protection against acts of terrorism.